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SEI: AN UPDATE

PRESENTED AT
SECOND SYMPOSIUM ON SPACE STATION EVOLUTION

JOHNSON SPACE CENTER

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Office of Aeronautics, Exploration and Technology

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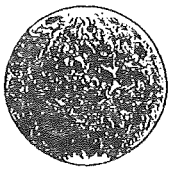
HUMAN EXPLORATION - KEY PREREQUISITES

Moon



Mars

Exploration Technology Program

- Options Enabling Mission Decisions
- Opportunities in Propulsion, Power, & Robotics
- Human Performance Capability

Robotic Missions

- Acquire Science & Engineering Data,Test Critical Systems & Technologies
- Select landing sites
- Define Environment in Which Spacecraft & Crews Must Function

Human Support

- Permit Safe, Productive Long Duration Stays for Humans in Space
- Provide Understanding of Issues, Capabilities, & Limits Associated with Zero-G & Artificial-G Space Flight

Space Station Freedom

- Life Science Research Program
- Technology Development Test Bed
- Operations Experience Base
- Possible LEO Transportation Node

Heavy-lift Launch Vehicle

- Earth to orbit transportation
- New Launch System

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SEI AND THE SYNTHESIS (STAFFORD) GROUP

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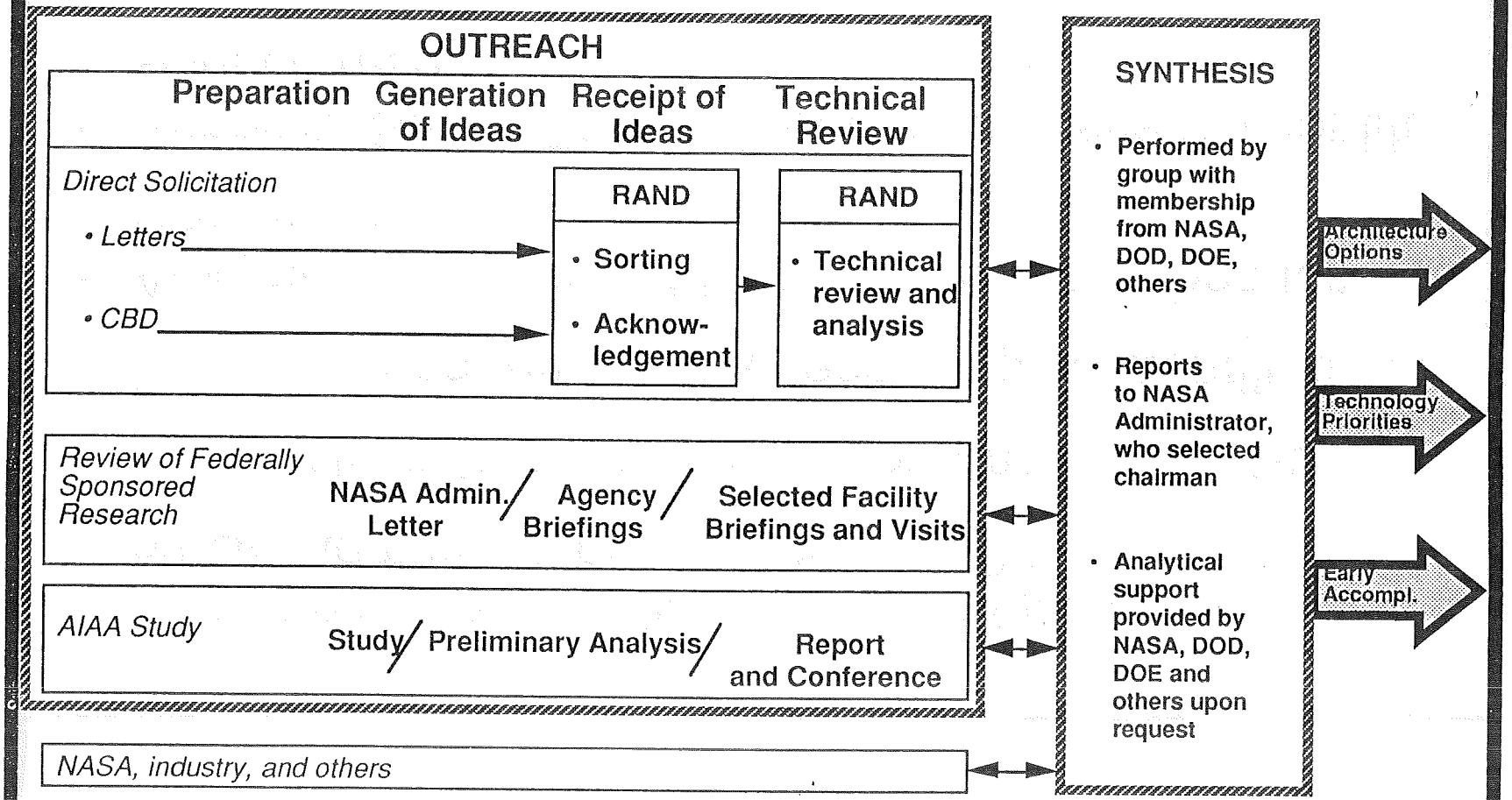
OUTREACH AND SYNTHESIS PROCESS



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SYNTHESIS STATUS

- Report delivered to Vice President Quayle and NASA Administrator on June 11, 1991
- Four distinct "architectures" (approaches) for SEI
- Fourteen long-lead critical technologies identified . . .
- Assumes major role of lunar phase is test-bed for Mars systems
- Supports Space Station Freedom as essential for life science research
- Initial assessment of Report in progress
- Formal study initiated July 1, 1991

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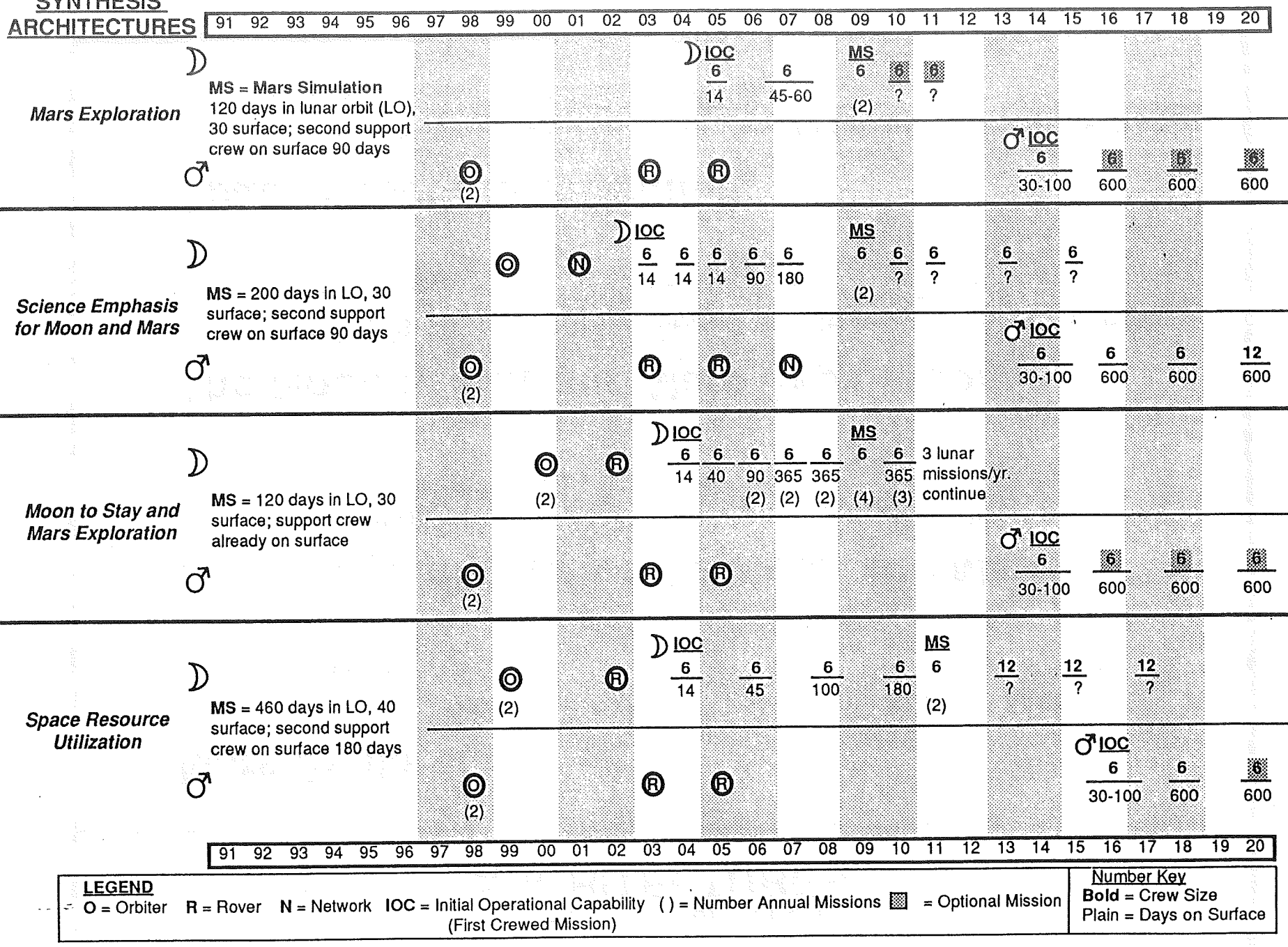
SYNTHESIS GROUP REPORT

ARCHITECTURES

- **Mars Exploration**
  - Emphasis on Mars, lunar activities simply support Mars missions
- **Science Emphasis for the Moon and Mars**
  - Exploration of both Moon and Mars, using the Moon as an observation platform
- **The Moon to stay and Mars Exploration**
  - Emphasis on a human presence on the Moon, with smaller crews engaged in exploration and science at Mars
- **Space Resource Utilization**
  - Emphasis on developing lunar resources for energy on Earth and for launch vehicle propellants

SCHEDULE ARCHITECTURE MILESTONES



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SYNTHESIS GROUP REPORT

SUPPORTING TECHNOLOGIES

1. Heavy lift launch with a minimum capability of 150 metric tons with designed growth to 250 metric tons
2. Nuclear thermal propulsion
3. Nuclear electric surface power to megawatt levels
4. Extravehicular activity suit
5. Cryogenic transfer and long term storage
6. Automated rendezvous and docking of large masses
7. Zero gravity countermeasures
8. Radiation effects and shielding
9. Telerobotics
10. Closed loop life support systems
11. Human factors for long duration space missions
12. Lightweight structural materials and fabrication
13. Nuclear electric propulsion for follow-on cargo missions
14. In situ resource evaluation and processing

RECOMMENDATIONS

(1) Establish within NASA a long range strategic plan for the nation's civil space program, with the Space Exploration Initiative as its centerpiece.

(2) Establish a National Program Office by Executive Order.

(3) Appoint NASA's Associate Administrator for Exploration as the Program Director for the National Program Office.

(4) Establish a new, aggressive acquisition strategy for the Space Exploration Initiative.

(5) Incorporate Space Exploration Initiative requirements into the joint NASA-Department of Defense Heavy Lift Program.

(6) Initiate a nuclear thermal rocket technology development program.

(7) Initiate a space nuclear power technology development program based on the Space Exploration Initiative requirements.

(8) Conduct focused life sciences experiments.

(9) Establish education as a principal theme of the Space Exploration Initiative.

(10) Continue and expand the Outreach Program.

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NEAR-TERM STRATEGY FOR SEI

- Analyze alternative mission architectures
- Perform wide array of system level studies
- Continue critical technology development
- Define enabling science requirements and opportunities for SEI science
- Focus key enabling activities that are transparent to architecture:
  - Human support research
  - Lunar/Mars robotic missions
  - Heavy-lift launch vehicle
  - Advanced propulsion and power

Near-term goals

- Definition of program options to support national decision
- Development of integrated architecture independent program plan
- Initiate critical near/far-term enabling activities

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HUMAN SUPPORT OBJECTIVE AND STRATEGY

Objective

- Develop SEI science, technologies, and procedures to satisfy requirements for crew life support and health maintenance

Strategy

- Characterize human needs to be met and risks encountered on SEI missions
- Determine acceptable biomedical, environmental and performance parameters for crew health, safety, and productivity
- Develop, and verify ground-based models, simulations, and assessment methods
- Develop, test, and validate technologies including risk abatement measures

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HUMAN SUPPORT ELEMENTS

Science, Technology and Operations will be integrated within each element to provide the required human support

SSF • ***Zero Gravity Countermeasures and Artificial Gravity***
- Understand mechanisms underlying physical debilitation and develop countermeasures
- Determine adequacy of countermeasures on SSF
- In parallel, develop artificial gravity concepts and simulations using ground based research and SSF

• Radiation Health and Radiation Protection
- Develop Solar Energetic Particle prediction capability
- Develop and validate measures of biological effects of galactic cosmic rays
- Develop and validate materials shielding analysis codes
- Characterize shielding materials in a design database
- Define shielding and other radiation countermeasure requirements
- Validate radiation health requirements using LIFESAT

• LIFESAT
- Two spacecraft, six missions planned around four launches; 6/96, 2/97 (2 s/c), 3/98 (2 s/c), 12/98
  - Determine the relationship between radiation and microgravity/gravitational effects on biological systems
  - Validate ground based assessments, models and simulations

SSF • ***Life Support Systems***
- Further develop applicable science and technology of regenerative life support, to include bioregenerative concepts as well as physical/chemical
- Develop and validate systems for contamination monitoring and control and for partial/full closure of air, water, food and waste, utilizing ground bases and SSF research
- Develop concepts for lunar and Mars in situ resource utilization (water, oxygen, etc.) to support exploration and other goals

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HUMAN SUPPORT ELEMENTS (continued)

- EVA (Surface)
  - Evolve planetary EVA systems to maximize productive EVA time through enhanced crew performance, more efficient portable life support functions, and improved durability, reliability, and maintainability
  - Validate surface EVA systems using developed lunar and Mars test-beds

SSF
- ***Human Factors***
  - Use analog facilities (e.g., Antarctica base, undersea habitat) to develop systems and procedures that will establish a physical, psychological and sociological climate favorable to crew living and work environments
  - Verify approaches using habitat and transfer vehicle simulation facilities
  - Use Space Station Freedom and lunar outpost as validation test-beds

SSF
- ***Advanced Medical Care***
  - Develop in-flight and ground-based support systems to provide remote medical care in event of injury or illness
  - Verify and validate systems using STS, SSF, lunar missions and analogs (Antarctica)

- Planetary Protection
  - Define the potential threats of planetary forward and back contamination
  - Develop, validate, and perform operational tests of protection equipment and procedures
  - Define and develop flight hardware for planetary protection management on Mars robotic and human missions

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UTILIZATION OF SSF

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SPACE STATION FREEDOM
SEI ACCOMMODATIONS

Objectives

- Support life sciences research and technology verification activities required for the Space Exploration Initiative
- Maintain the design flexibility to support on-orbit processing of lunar and Mars spacecraft

Strategy

- Identify architecture independent requirements on SSF to support SEI and define corresponding program
  - Primarily R&D activities (Life Sciences and technology verification)
  - Supports continued development of SSF into a life sciences and technology test-bed configuration by 2004
- Continue a broad research program which maintains Space Station Freedom development options to support architecture specific roles
  - Includes transportation node (vehicle processing) activities
  - Supports continued development of SSF into a transportation node by 2007 if needed while minimizing near-term costs
- Focus near-term efforts on advanced studies and long lead time advanced development for selected technologies

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SPACE STATION FREEDOM
SEI ACCOMMODATIONS
(Continued)

Content

- Space Station Freedom augmentations for life sciences and R&T to support to SEI
  - Systems definition and integration studies
  - Additional habitation module for increased crew size
  - Increased power through addition of high-efficiency power generation systems (e.g., solar dynamic)
  - Subsystem upgrades associated with adding power (thermal, utility distribution, etc.)
  - Advanced technology development

- Space Station Freedom augmentations to provide SEI transportation node
  - Additional structure for attaching facilities
  - Advanced suit and second airlock for increased EVA
  - Lunar Transfer Vehicle accommodations facility
  - Cargo Transfer Vehicle accommodations (option)
  - Advanced propulsion system
  - Advanced Automation and Robotics program to reduce EVA requirements

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SUMMARY

- Near-term SEI activities stress development of an integrated program plan linking SEI-related research and advanced development to mission milestones based on a "common keel" that supports all architectures

- Focused life sciences research, technology development and space qualification heavily dependent on SSF availability and evolving capabilities

- Some SEI architectures may impose special additional requirements on SSF, e.g. transportation node role, in-space servicing support for SEI mission systems